

vided as a single continuous coating, such optical effects may not be apparent if the coating is relatively uniform across the viewable area of the device. In devices that use a transparent conductor pattern, it may be possible to distinguish the areas covered by the pattern from the areas not covered by the pattern due to a difference in optical effects. This can be distracting to the user, and in some applications may be undesirable from an aesthetic point of view. For example, in environments where the device may be exposed to high ambient light conditions, the transparent conductor pattern of the touch sensor device may be undesirably visible even when the underlying display is off.

[0017] The present invention provides a touch screen construction that includes a transparent conductor pattern and is configured so that the transparent conductor pattern is less visibly distinguishable. The touch screen construction of the present invention can increase light transmission and decrease reflections in areas covered by the transparent conductor pattern to thereby reduce the visibility of the pattern. In constructions of the present invention, the touch screen substrate includes a coating covering a substrate and having a lower index of refraction than that of the substrate. The transparent conductor pattern is then disposed over this lower index coating. The transparent conductor pattern also has a higher index of refraction than that of the coating. Without wishing to be bound by any theory, the optical thicknesses of the transparent conductor layer and the coating are in a range so that they form, with the substrate, an antireflection stack that functions to reduce reflections of visible light through destructive interference of light waves reflected at the substrate/coating and coating/transparent conductor interfaces. This in turn increases the transmission of light through the touch screen, for example from a display positioned behind the touch screen, and reduces reflection of light from in front of the touch screen. As such, the overall optical effect of the transparent conductor pattern is lessened, thereby making the pattern less distinguishable from areas uncovered by the pattern, and therefore less visible. Additionally, the overall brightness and contrast of the display can be improved due to the increased transmission and reduced external reflections.

[0018] Constructions of the present invention also include a material disposed over and substantially covering the transparent conductor pattern so that the material contacts the underlying coating in areas uncovered by the transparent conductor. In this way, the material fills the gaps between portions of the transparent conductor pattern so that the interface in the areas not covered by the pattern is an interface between the underlying coating and the material disposed over the pattern rather than an air interface with the underlying coating. Air interfaces can produce a relatively high index of refraction difference that can lead to undesirably high interfacial reflections, thereby reducing transmission of light through the touch screen and/or reducing contrast of an image viewed through the touch screen, for example due to ambient light reflections. The filler material disposed over the transparent conductor pattern can be selected to reduce reflections at the interface between the substrate coating and the filler material, thus increasing light transmission through the touch screen in areas uncovered by the transparent conductor. The material disposed over the transparent conductor pattern can be any suitable light transmissive material, including an adhesive material. The adhesive material can be used to bond the touch screen

construction to another substrate, to a display device, or to another suitable object for mounting or enclosing the touch screen construction.

[0019] In a construction of the present invention that includes a substrate, a coating on the substrate, a transparent conductor pattern on the coating, and a filler material disposed over the transparent conductor pattern and filling the gaps between portions of the pattern, exemplary material selections may yield the following refractive indices for each respective component: substrate index of about 1.6 to 1.7 (for example about 1.67 for a polyethylene terephthalate substrate); coating index of about 1.4 to 1.5 (for example about 1.45 for a silicon dioxide coating); transparent conductor index of about 1.8 to 2.1 (for example about 2.0 for indium tin oxide); and filler material index of about 1.4 to 1.8 (for example about 1.7).

[0020] The present invention is particularly suited to touch screen constructions that include a plastic substrate such as polyester, for example polyethylene terephthalate (PET). The phenomenon of transparent conductor pattern visibility has been observed by the present inventors to be more pronounced when PET or other flexible plastic films are used as substrates as opposed to when glass is used as a substrate. When glass is used as a substrate, an ITO pattern is typically annealed at temperatures between 300° C. and 400° C. When PET or another temperature-sensitive material is used as a substrate, an ITO pattern cannot be processed at such high temperatures. As a result, ITO patterns on PET may need to be made thicker when compared to those formed and annealed on glass to achieve the desired sheet resistance and uniformity. This can lead to a more visibly noticeable transparent conductor pattern. The present inventors have also observed that the resistance uniformity of an ITO pattern on a PET substrate can be improved by disposing a silicon oxide (e.g. SiO₂) coating between the PET substrate and the ITO pattern.

[0021] While various aspects of the present invention can be understood with reference to the Figures, the embodiments shown and described by way of example are illustrative but not exhaustive of the full scope contemplated.

[0022] FIG. 1 shows a touch screen construction 100 of the present invention that includes a substrate 110, a coating 120 covering the substrate 110, a patterned transparent conductor layer 130 disposed on the coating 120, and a filler material 140 disposed over the transparent conductor pattern 130, the filler material 140 contacting the coating 120 in areas not covered by the transparent conductive material. Touch screen construction 100 can be used in a user activated touch input device where the transparent conductor pattern 130 provides the touch sensing elements.

[0023] Surface 112 of the substrate or surface 142 of the filler material can provide the touch surface. Alternatively, one or more additional layers can optionally be disposed between the user and the substrate 110 or filler material 142 for providing a touch surface. For example, a removable and replaceable overlay can be provided so that the touch screen touch surface can be “refreshed” if the touch surface becomes scratched or otherwise damaged. As another example, a hardcoat can be disposed on surface 112 of substrate 110 to provide a touch surface, particularly when substrate 110 is a plastic substrate. As another example, a sheet of glass or other material having desirable durability or